

A NEW *BEPHRATELLOIDES* (HYMENOPTERA: EURYTOMIDAE) FROM
SEEDS OF *CYMBOPETALUM* (ANNONACEAE) IN MEXICO

E. E. GRISELLE AND M. S. FOSTER

(EEG) Systematic Entomology Laboratory, PSI, Agricultural Research Service, U.S. Dept. of Agriculture, % National Museum of Natural History, MRC 168, Washington, DC 20560, U.S.A.; (MSF) National Biological Service, National Museum of Natural History, Washington, DC 20560, U.S.A.

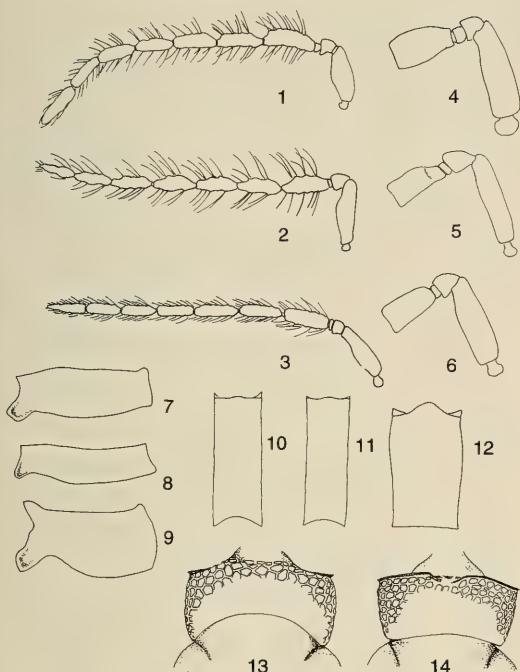
Abstract.—*Bephratelloides ablusus* Grissell and Foster, new species, is described and illustrated based upon specimens that emerged from seeds of *Cymbopetalum mayanum* (Annonaceae) in southern Mexico. This is the first species of *Bephratelloides* that is associated with a host other than *Annona*. *Bephratelloides ablusus* is compared with its congeners from which it differs in minor character states. No external morphological characteristics suggest a specialized association with *Cymbopetalum*.

Key Words: Hymenoptera, Eurytomidae, *Bephratelloides ablusus*, new species, *Cymbopetalum mayanum*, *Annona*, Annonaceae, seed

Species of *Bephratelloides* have previously been reported as seed-feeders in the fruit of *Annona* (Annonaceae) (Grissell and Schauff 1990). Species of *Annona* are cultivated in the tropics under many common names such as cherimoya, custard apple, soursop, guanabana, sugar apple, and atemoya (a commercial cultivar). In this paper we describe the new species *Bephratelloides ablusus*, which feeds in the seeds of a newly discovered host, *Cymbopetalum mayanum* Lundell (Annonaceae), in southern Mexico. Unlike *Annona*, *Cymbopetalum* is not eaten by humans, but its aril (the partial outer covering of the seed) serves an important function as forage for birds. More than 40 species of birds have been observed to feed on *Cymbopetalum* aril, including 12 species of Nearctic migrants (Foster, unpubl. data). The fruiting period of *Cymbopetalum* coincides with the northward spring migration of these birds, which accounts for about 70% of all bird feeding visits to *Cymbopetalum* trees.

Cymbopetalum, which is closely related to *Annona*, has 27 species ranging from Mexico to Brazil (Fries 1962, Murray 1993). According to Fries (1962), the family Annonaceae contains 35 genera in the Americas, and the genus *Annona* has over a hundred species. Genera related to *Annona* and *Cymbopetalum*, such as *Xylopia*, *Porcelia*, and *Rollinia*, contain well over 100 additional species. With such diversity at both the generic and specific levels, the probability seems high that other phytophagous species of *Bephratelloides* await discovery and that the host range of these species may be wider than is recognized.

The genus *Bephratelloides* was last revised by Grissell and Schauff (1990), who recognized four valid species: *B. cubensis* (Ashmead), *B. paraguayensis* (Crawford), *B. petiolatus* Grissell and Schauff, and *B. pomorum* (Fabricius). Three of these species are seed-feeders in *Annona*, but the host of *B. petiolatus* is unknown. The taxonomic position of two additional species,



Figs. 1-14. *Bephratelloides* spp. 1-3, Male antenna. 1, *B. ablusus*. 2, *B. petiolatus*. 3, *B. paraguayensis*. 4-6, Female antenna, scape to funicular segment 1. 4, *B. ablusus*. 5, *B. petiolatus*. 6, *B. paraguayensis*. 7-12, Male metasomal petiole (Mt1). 7-9, Lateral view. 10-12, Dorsal view. 7, 10, *B. ablusus*. 8, 11, *B. petiolatus*. 9, 12, *B. paraguayensis*. 13-14, Pronotum, dorsal view. 13, *B. ablusus*. 14, *B. paraguayensis*.

B. limai (Bondar) and *B. melleus* (Westwood), is unclear because their types are lost (Grissell and Schauff 1990). Species of *Bephratelloides* are restricted to the Neotropical Region except for accidental introductions because of commerce associated with *Annona* culture in Florida (Bruner and Acuna 1923) and Hawaii (Heu 1988).

***Bephratelloides ablusus* Grissell and Foster, NEW SPECIES**

(Figs. 1, 4, 7, 10, 13, 15, 18, 21, 24-26)

Description.—Female length 4.0 to 5.8 mm. Body color predominantly black with orange to yellow markings as follows: antenna including scape, head (except ocellar triangle, occiput, and sometimes area laterad torulus), lateral side of pronotum, scutellum and usually posterior of mesoscutum

(may be nearly entirely black with only slight indication of dark-orange color), tegula, apices of femora, tibiae (except apex white), foretarsus, mid- and hind tarsomeres 4 and 5 (1-3 white), metasoma ventrolaterally at least on Mt4 to posterior of metasoma, Mt6-8 may be entirely to only laterally orange; wing veins dark brown with hyaline break between apex of parastigma and base of marginal vein, membrane posterad marginal vein with dark-brown infuscation paralleling vein (Fig. 15; may give vein an enlarged and triangular appearance), wing mostly hyaline with weak infuscation extending from marginal and stigmal veins half-way to posterior margin of wing. Head and mesosoma mostly covered with setigerous punctures, interstices between punctures with conspicuous micropunctuation; malar area (Fig. 24) without setigerous punctures (distance between nearest punctures 2 or 3× own diameter), surface shagreened, with polished pit at lower eye margin; metasoma polished. Eye height about 1.3× malar distance (Fig. 18), ocellular distance about 1.2× post-ocellar distance (Fig. 21), antenna with first funicular segment slightly constricted at base (Fig. 4), all funicular segments longer than wide. Mesoscutum in longest median view about 1.7× length of pronotum and subequal to length of scutellum; anterior margin of pronotum with carina laterally (i.e. along vertical margin) that curves slightly onto dorsal surface but then disappears medially (Figs. 13, 24); scutellum in dorsal view with apex somewhat pointed and without emargination, essentially flat to slightly depressed in profile, scarcely projecting beyond dorsellum (Fig. 25); metanotum perpendicular to plane of scutellum; propodeum (Fig. 26) medially with well-defined, nearly parallel-sided furrow, furrow slightly wider dorsally than ventrally, divided into rectangular sections by transverse carinae and without setae, basolaterad furrow with reticulate to shagreened triangular area abutting setigerous cells, anterodorsolateral edge of furrow with large, polished

bare cell. Forewing (Fig. 15) with postmarginal vein not projecting beyond apex of stigma and about $0.5\times$ length of marginal vein, speculum a horizontal <-shaped area, cubital vein with setae basally, lower surface of costal cell with numerous setae arranged in erratic rows, upper surface of costal cell with complete row of setae along anterior margin and several incomplete rows in apical half of cell. Metasoma about $2\times$ length of mesosoma, about $3\times$ as long as wide (in dorsal view), essentially horizontal, petiole (Mt1) about $3\times$ as broad as long (usually difficult to see), dorsomedially with an upward projecting carina.

Male.—Length 3.4 to 4.8 mm. Similar to female, except more variable in color as follows: body sometimes entirely black except apices of femora, tibiae, tegula, and lower face around clypeus yellowish, or color as for female (most specimens) except fore- and midlegs (including coxae) all yellow to orange, hind coxa partially yellow, ventral half of mesosoma yellow, and Mt2–8 yellow laterally. Antenna (Fig. 1) with elongate, cylindrical funicular segments, setae erect, somewhat aligned in rows separated by distinct bare areas and longer than width of segment; propodeum as for female except sculpture usually less distinct (i.e. carinae effaced) and lateral shagreened triangular area either absent or poorly delimited; metasomal petiole (Mt1) dorsally about $2.5\text{--}2.7\times$ as long as wide (Fig. 10) and without apical dorsomedian flange (best seen in profile, Fig. 7; cf. Fig. 9).

Distribution.—Known only from the type locality in southern Mexico (Chiapas).

Host.—*Cymbopetalum mayanum*.

Type material.—Holotype female on point with data: Chajul, Zona Marqués de Comillas, Chiapas, Mexico, $16^{\circ}06'45''\text{N}$, $90^{\circ}55'32''\text{W}$, P. S. Wenninger, M. S. Foster collectors, elev. 185 m, seeds coll. 12 April, 1993, em. 13 April, ex fruits of *Cymbopetalum* (deposited in Universidad Autónoma de México, Mexico City). Paratypes: 16 females, 14 males with same data as holotype except some seeds collected 13 April with

emergence several days later: 8 females, 6 males deposited in U.S. National Museum, Washington, D.C.; three pairs each in the Universidad Autónoma de México, Mexico City and the Centro de Investigaciones Ecológicas del Sureste, San Cristóbal de las Casas, Chiapas; one pair each in The Natural History Museum, London and the Canadian National Collection, Ottawa.

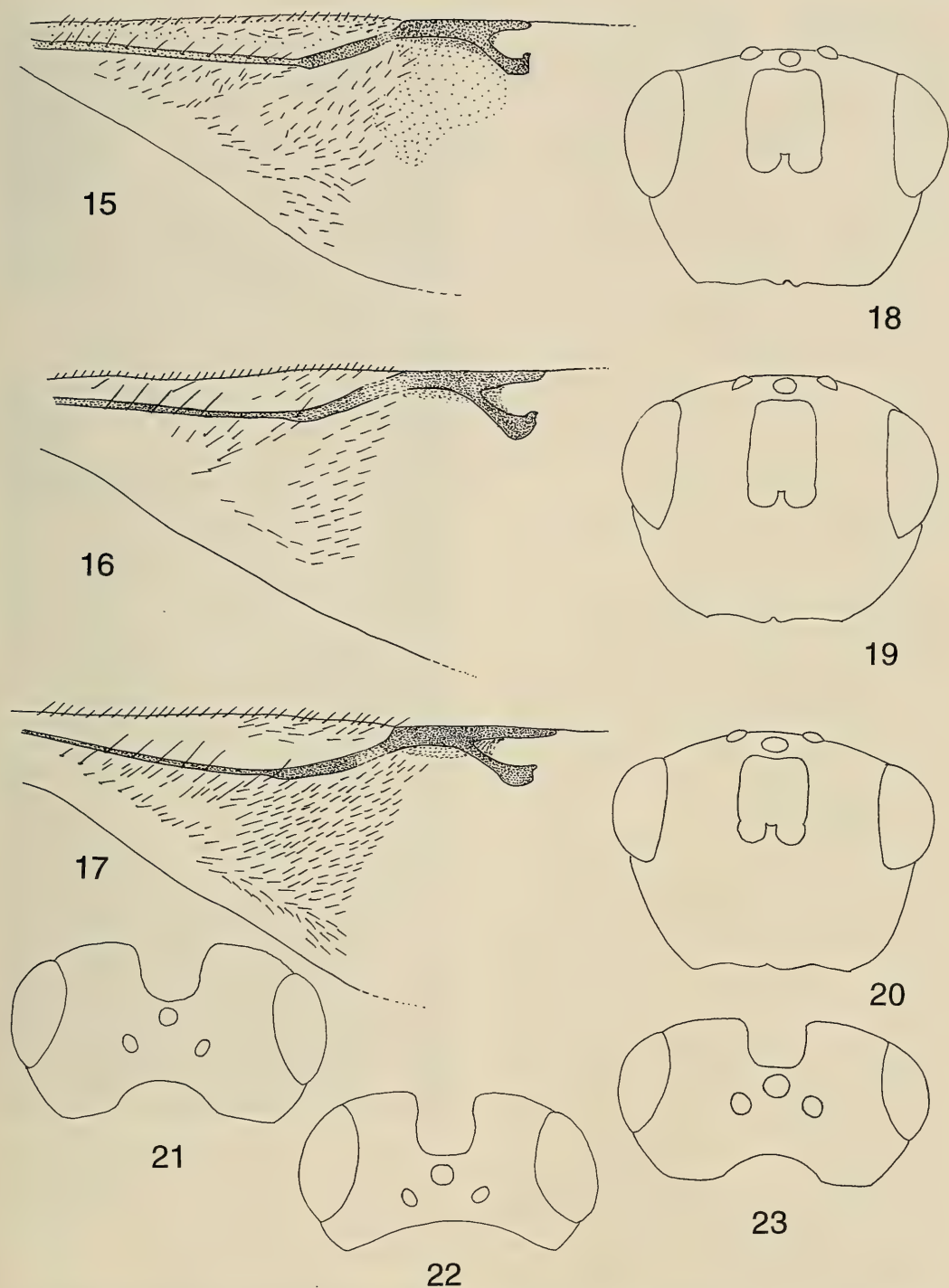
Etymology.—From the Latin "*ablusus*" meaning to "differ" or "be unlike", in reference to the host of this species being different from that of other known species of the genus.

Host plant remarks.—Mature fruits were present at Chajul over a period of about 6 weeks (Foster, unpubl. data). In 1991 and 1993, the main fruiting period ran from about the second week of March to the third week of April. In 1992, however, the fruiting period was shifted about one month later.

Fruits of *C. mayanum* are apocarpic and at Chajul included from 5 to 19 sausage-shaped monocarps (Fig. 27). Monocarps ranged from 4.7 to 7.9 cm in length and from 2.3 to 3.2 cm in diameter. They were largely green when mature, although the exposed abaxial surface was often maroon. When ripe, a monocarp dehisces longitudinally along its abaxial surface to expose two rows of laterally flattened elliptical seeds embedded in cream colored endocarp (Fig. 27). The seeds at Chajul were a shiny, dark purplish black, 11.5 to 18.0 mm long, 6.5 to 9.8 mm wide, and 4.0 to 6.6 mm deep. A bright red-orange aril enveloped the central portion of each seed, leaving the tips and a narrow zone on the distal surface of the seed exposed.

Seeds infested with wasps were easily spotted. Although they generally developed to normal size, they usually were maroon rather than black. Also, the arils enfolding parasitized seeds were tan to yellow-brown.

All parasitized seeds examined contained only a single wasp adult, pupa, or larva. However, one seed with an exit hole also contained a wasp that was about to emerge.

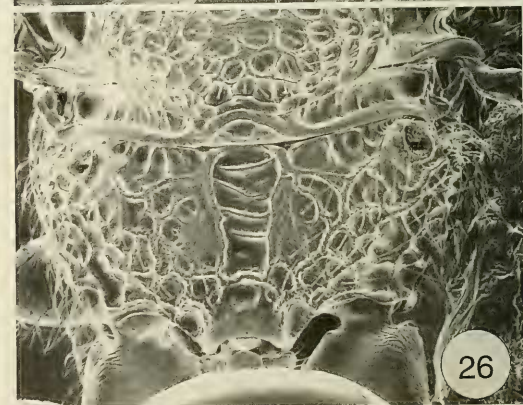


Figs. 15-23. *Bephratelloides* spp. 15-17, Forewing. 15, *B. ablusus*. 16, *B. petiolatus*. 17, *B. paraguayensis*. 18-20, Face, front view. 18, *B. ablusus*. 19, *B. petiolatus*. 20, *B. paraguayensis*. 21-23, Head, dorsal view. 21, *B. ablusus*. 22, *B. petiolatus*. 23, *B. paraguayensis*.

This observation suggests that more than one wasp may develop in some seeds. Wasp exit holes were located at the abaxial ends of seeds, above the level of the aril. Such holes often could be seen in seeds in situ (Fig. 27b). Exit tunnels (Fig. 27a) were followed from the exit holes through the carpel tissue to the surface of the monocarp (Fig. 27c). Such tunnels did not necessarily go directly to the surface, and some were several cm long. Endocarp tissue is soft and probably easily traversed by a wasp. The pericarp is moderately hard. Emergence holes were often visible on the surface of the pericarp and were about 1 mm in diameter on vacated fruit. Wasps often exited the monocarp before it dehisced.

In 1991, the junior author examined 78 monocarps from 3 trees; 51.3% (40) contained one or more seeds with wasps or wasp larvae. In 1993, 53.3% (8) of 15 monocarps examined contained seeds parasitized by wasps. In contrast, none of 25 monocarps examined in 1992 showed evidence of parasitism. Monocarps contained from 6 to 19 seeds (median = 14.2); those with parasites contained from 1 to 5 (median = 1.75) parasitized seeds.

Discussion.—Although *Bephratelloides ablusus* emerged from seeds of a genus of hosts different from that of its known congeners, the species apparently does not reflect any unusual morphological developments as a result of the association. In females the construction of the propodeum (most notably the presence of lateral, shagreened, irregular triangular areas) is somewhat different from that of other species, but males do not show this structure consistently. Based upon a majority of characters, *B. ablusus* appears intermediate between *B. paraguayensis* and *B. petiolatus*, although it shares more characters in common with the latter species than the former. These differences are outlined in the following key couplets, which are intended to replace the key to species of *Bephratelloides* given by Grissell and Schauff (1990). Couplets 1 and 2 also must be simplified as



Figs. 24–26. *Bephratelloides ablusus*, scanning electron micrographs. 24, Head, lateral view. 25, Mesosoma, lateral view. 26, Metanotum and propodeum, posterior view.

well in order to accommodate the new taxon.

1. Cells of median area of propodeum with setae and similar to cells on remainder of propodeum
 *B. pomorum* (Fabricius)

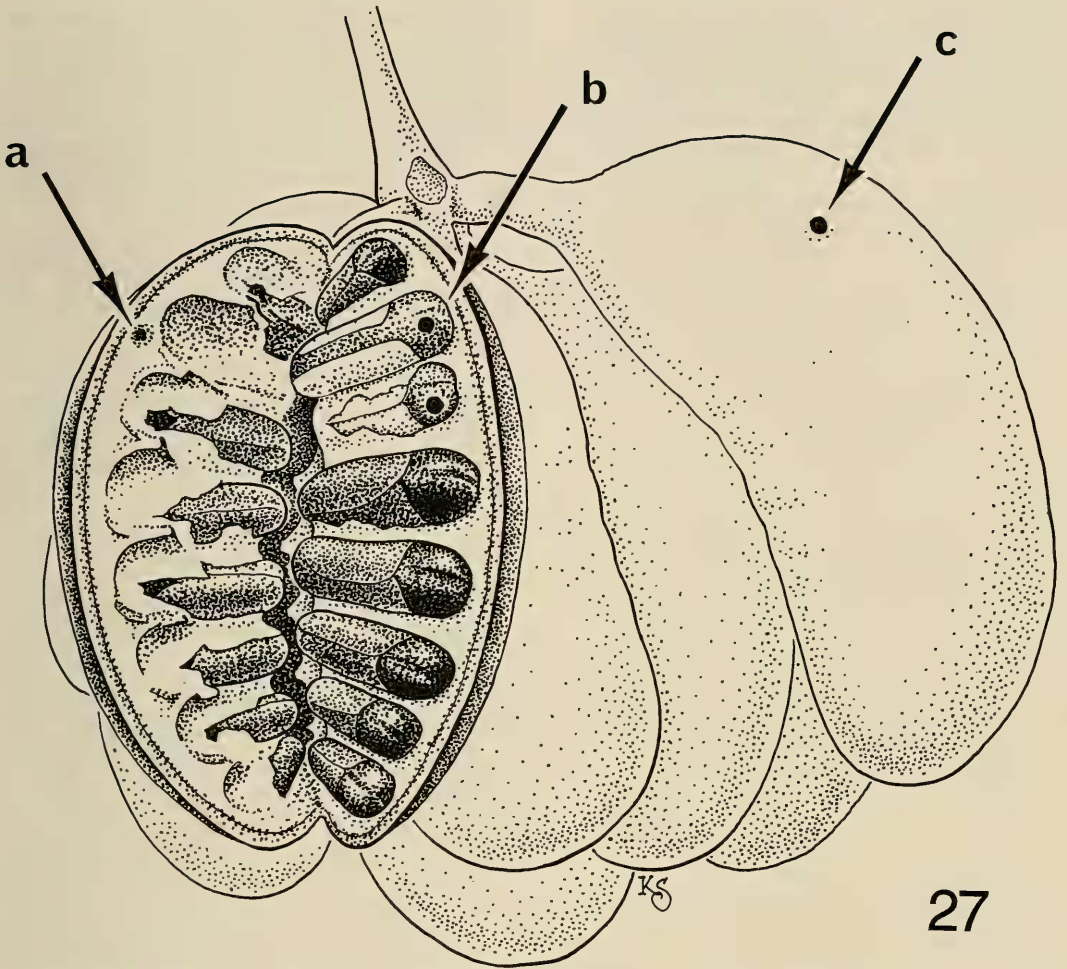


Fig. 27. Apocarp of *Cymbopetalum mayanum* with one dehisced monocarp. Mature, unparasitized seeds are black and enveloped in a bright red-orange aril. Parasitized seeds (b) are maroon and have tan to yellow-brown arils. Wasps exit through a hole (b) at the tip of the seed, and tunnel (a) through the carpel tissue to emerge through a hole (c) at the surface of the monocarp.

- Cells of median area of propodeum without setae, these cells either absent in upper half, transverse (and thus different than lateral cells, Fig. 26), or forming two parallel vertical median rows 2
- 2. Median area of propodeum lacking distinct carinae in upper half which is flat and glabrous *B. cubensis* (Ashmead)
- Median area of propodeum completely carinate, either with distinct transverse carinae (Fig. 26) or with parallel vertical rows 3
- 3. Both sexes: malar space without setigerous punctures (i.e. widest bare area 2 or 3× puncture diameters in width; Fig. 24); eye height greater than malar distance (Figs. 18, 19); speculum present although possibly small (Figs. 15, 16). Females: first funicular segment constricted at base (Figs. 4, 5); Mt1 (petiole) usually not readily visible and much wider than long (2.5 to 3×). Males: funicular segments with erect setae longer than width of segment (Figs. 1, 2); Mt1 in dorsal view more than 2.5× as long as broad (Figs. 10, 11), in lateral view (Figs. 7, 8) more than 2.5× as long as greatest height, without apical dorsomedian flange. . . . 4
- Both sexes: malar space with nearly contiguous setigerous punctures (i.e. widest bare area 1× or less puncture diameter in width); eye height less than malar distance (Fig. 20); speculum essentially absent (Fig. 17). Females: first funicular segment cylindrical, not constricted at base (Fig. 6); Mt1 about as wide as long.

Males: funicular segments covered with recurved setae that are scarcely as long as width of segment (Fig. 3); Mt1 in dorsal view about 1.5× as long as wide (Fig. 12), in lateral view (Fig. 9) subequal in length to greatest height, with apical dorsomedian flange

- *B. paraguayensis* (Crawford)
4. Both sexes: anterior pronotal carina nearly meeting medially (Fig. 14), separated by distance subequal to or less than post-ocellar distance; post-ocellar distance greater than ocellocular distance (Fig. 22); speculum relatively large (Fig. 16); cubital vein without setae basally; median propodeum with two vertical rows of cells (though these may be irregular and difficult to discern). Females: basal constriction of first funicular segment asymmetrically bent (Fig. 5)
- *B. petiolatus* Grissell and Schauff
- Both sexes: anterior pronotal carina scarcely curving over onto dorsal surface before becoming obsolete (Fig. 13), separated by distance much greater than post-ocellar distance; post-ocellar distance less than ocellocular distance (Fig. 21); speculum relatively small (Fig. 15); cubital vein with setae to base; median propodeum with single transverse cells (Fig. 26). Females: basal constriction of first funicular segment essentially symmetrical (Fig. 4)
- *B. ablusus* Grissell and Foster

In addition to the key characters just given, *B. ablusus* and *petiolatus* appear to differ slightly in wing venation from *B. paraguayensis*, but the character is variable enough to make its use questionable without additional material for study. In both species the postmarginal vein extends barely to the apex of the stigma (Figs. 15, 16) or slightly beyond, whereas in *B. paraguayensis* the postmarginal vein projects distinctly beyond the apex of the stigma (Fig. 17). This difference is reinforced somewhat by the relative lengths of the postmarginal and marginal veins. In *B. ablusus* and *B. petiolatus* the postmarginal vein is about one-half to three-fourths the length of the marginal vein, whereas in *B. paraguayensis* it is three-fourths to subequal in length with the marginal vein. The differences are not entirely distinct but may eventually lend an additional piece of evidence to the understanding of the relation-

ships between *B. ablusus*, *B. petiolatus*, and *B. paraguayensis*. The only characters that *B. ablusus* and *B. paraguayensis* share are the configuration of the pronotal carinae (as in Fig. 13), and the post-ocellar distance being less than the ocellocular distance (Figs. 21, 23).

Based upon an earlier study of *Bephratelloides* (see comments in Grissell and Schauff 1990), we are confident that *B. ablusus* is conspecific with neither *B. limai* nor *B. melleus*. Although the types of these latter two species cannot be found, their descriptions offer enough detail, especially in color, to exclude them from confusion with *B. ablusus*.

ACKNOWLEDGMENTS

We thank Aaron Goldberg and Stephen Smith (Department of Botany, Smithsonian Institution) for assistance with plant identification and references to Annonaceae; Terri Taylor (Systematic Entomology Laboratory) for the scanning electron micrographs; Kate Spencer (National Biological Service [NBS]) for the drawing in figure 27; Paul Wenninger and Gabriela Domínguez (NBS) for assistance in the field; and Richard White and Ron Hodges (Systematic Entomology Laboratory), Gary Gibson (Agriculture Canada, Research Branch, Ottawa), Steve Heydon (University of California, Davis), and Christine Nalepa (North Carolina Department of Agriculture, Raleigh) for reviewing and commenting on the manuscript. We also are indebted to the Mexican government (Secretaría de Desarrollo Urbano y Ecología [SEDUE] and Secretaría de Desarrollo Social [SEDESOL]) for permission to work in the Montes Azules Biosphere Reserve and environs, and for permission to collect specimens of the wasp.

LITERATURE CITED

- Bruner, S. C. and J. Acuna. 1923. Sobre la biología de *Bephrata cubensis*, Ashm., el insecto perforador de las frutas anonáceas. Revista de Agricultura, Comercio y Trabajo 5(7): 21–30. [An

- unchanged reprint of this paper was published in 1967 by Academia de Ciencias de Cuba, Instituto de Agronomía, as Serie Agrícola No. 1: 1-14.]
- Fries, R. E. 1962. Annonaceae, pp. 179-213. *In* R. E. Woodson, R. W. Schery, and collaborators, Flora of Panama. Annals of the Missouri Botanical Garden, Pt. IV, Fas. 5 (Nymphaeaceae to Monimiaceae) 49: 137-255.
- Grissell, E. E. and M. E. Schauff. 1990. A synopsis of the seed-feeding genus *Bephratelloides* (Chalcidoidea: Eurytomidae). Proceedings of the Entomological Society of Washington 92: 177-187.
- Heu, R. 1988. *Bephratelloides* (= *Bephrata*) *cubensis*. [In minutes, notes, and exhibitions, February.] Proceedings of the Hawaiian Entomological Society 28: 4.
- Murray, N. A. 1993. Revision of *Cymbopetalum* and *Porcelia* (Annonaceae). Systematic Botany Monographs 40: 1-121.